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The May-Beetle in Forest Nurseries and Experiments Relative to Its Eradication.

by

A. J. Jaenicke, Forest Assistant,
Fort Valley Experiment Station.

Character of Injury.

Usually the lateral roots of both transplants and seedlings are cut off by the larvae. Very often the entire root system with the exception of a few inches of the strong root immediately below the root collar is cut off. When this is the case, the plant shrivels, the foliage dies, and the young seedling or transplant can be easily pulled out of the ground. The injury does not occur regularly over the beds, but is concentrated in patches 2-3 feet in diameter. Very often a number of successive plants in a row are injured or killed, which is evidence of the fact that the larva can move slowly through the soil to its food. At the Experiment Station the extent of the damage has not been regular from year to year. In one year approximately ten per cent of the transplants were killed from this cause, and in the year preceding the damage was very much less. The damage from May-beetle larvae is not confined to the plants which are killed, but extends also to many transplants which are not killed outright but have the root system injured to such an extent that their use for field planting is very undesirable.

Copy for Mr. Mitchell

Two-year seedlings are also attacked, but to a much lesser degree.

On investigation, the writer found that the May-beetle larvae have been giving much trouble in forest nurseries in the New England States for several years. The injury is very similar to that at Fort Valley, but is not confined to the vonifers. Deciduous species of all kinds are attacked in the nursery.

In the last report of the Connecticut Experiment Station, Dr. Britton, the State Entomologist, reports severe loss on the nurseries of the Northeastern Forestry Company at Cheshire, Conn. Here white pine is grown most extensively. During the past year 25% of the seedlings (or tansplants?) either lost their roots entirely or were so severely injured as to make them unfit for field planting. Hardwood seedlings were also attacked but to a much lesser extent. The only method of control that has been used is the actual digging up of the larvae when injury is found on a definite situation. The white pine seedling or transplant wilts immediately after severe injury by the larvae and so its presence is easily detected. In order to dig out the larvae, many neighboring plants had to be removed, and this involved loss of healthy plants and great expense.

In 1907, in one of the large State forest nurseries in New York State, the damage to white pine and Scotch pine stock was very serious. Each plant had been cut off from 1/4 to 1/2 inch below the surface of the ground, and the roots com-

pletely disappeared. The injury in this nursery continued till the middle of September of that year. The leaves of the seedlings would droop soon after the attack. The larvae were thus located. As in Connecticut, the larvae were dug up with the same disadvantages of excessive cost and loss of healthy stock by disturbance. It was planned to carry on the following campaign against the larvae the next year:

1. Three-fourths of the nursery was to be plowed and a man detailed to follow the plow to pick up the grubs.

2. Use of trap lanterns to catch the adults at night.

3. During the growing season, whenever injury occurred, the grubs were to be dug out in the situations indicated by the injury.

Because of the fact that the nursery was located too far from proposed field plantings, it was entirely abandoned the very next year, and hence nothing was possible along these lines.

In 1909 another New York State nursery suffered severe injury from the same cause. The digging up of the larvae was again resorted to, with the resultant damage to the trees which had to be reset.

In both Connecticut and New York, the larvae in question were positively identified as larvae of May-beetles by competent entomologists. There are many instances on record of injury to forest nurseries which might be quoted. The injury in all cases is the same, and in no case is a satisfactory method of control brought forward.

Life Histroy of the May-Beetles.

The May-beetles belong to the genus Lachnosterna, and over 60 species have been described in the United States. It is remarkable that with but one exception (L. Aristis) the life history of none of the genus has been carefully worked out. S. A. Forbes, State Entomologist of Illinois, who has given Lachnosterna almost his entire attention during the past few years, believes that there is little variation in the general life history of the various species of the genus.

Soon after pairing in June or July, the female creeps into the earth and deposits her eggs one at a time to the number of forty or fifty, at depths varying from one to six inches below the surface of the ground. The egg is mucilaginous, and hence the earth immediately around it sticks to it and forms a pellet of earth with a single egg in the center. These pellets of earth are quite conspicuous and can be found by careful screening of the soil. The egg-laying period ordinarily does not occupy more than a month--the normal length of life of the adult after it emerges.

The eggs hatch within two weeks, or three weeks at the most. The larvae grow slowly and do not attain full size until the early summer of the third year. During the summer months the larvae feed near the surface of the soil, but on the approach of winter they descend below the frost line as a protection against cold. Larvae found in frozen soil are invariably dead. As soon as the frost leaves the ground in the spring, they come up from their winter quarters and resume feeding. The larvae are

most voracious and damaging just before they have attained full growth. Although sluggish in their movements, they have no trouble in finding their way to supplies of food which may happen to be close by.

In June or July of the third year, the larvae construct an ovoid chamber, lined with a gelatinous fluid, and here change into pupae.

Ordinarily the pupal stage lasts but two months, and so the pupae become adults in August or September. These adults do not emerge that fall but over-winter in the ground, and emerge as beetles the following May or early June. Frost does not seem to injure the adults very much, so they remain in the pupal case which is located within the first few inches of surface soil.

On emerging from the ground in the spring, the beetles feed on deciduous trees if these are present, or on grasses if trees are not present. The beetles feed and copulate almost entirely at night and carry on their work of egg deposition during the day. As already stated, the adults do not live more than four to six weeks after emerging from the ground in May or June.

The May-beetles have many natural enemies, and these are very important in the reduction of their numbers. Only the more important ones will be mentioned. Among the insects, there are various genera of flies which are parasitic on the larvae of the May-beetle and are exceedingly abundant. Often the entire disappearance of May-beetle larvae in a given year is attributable to the work of these parasitic flies. Several fungi are

exceedingly destructive to the larvae of the May-beetle, one of which has been used considerably in control work.

Methods of Control.

The literature on this subject, although extensive, is not very suggestive. Plowing of the land infested, and hand-picking of the larvae turned over is a method recommended again and again. The following however are very suggestive in outlining some things which might be of value in future investigation on methods of control:

1. Kerosene emulsion. This has been used with great success on lawns which were infested with grubs very similar to the larvae of May-beetle. 15 gallons of emulsion are made which has as its constituent 10 gallons of oil, 5 lbs. of soap and a little water. This is diluted to 300 gallons. For several days previous to the treatment the soil is kept thoroughly drenched with water. The diluted emulsion is then applied to the soil. Although this method has been attended with much success on lawns, its value in forest nurseries is questionable.

2. Sulphate of potash applied in solution of water at the rate of 5 pounds per 100 square feet of surface in much the same manner as the kerosene emulsion is applied to water-soaked soil has proven effective in several instances.

3. The use of a destructive fungus. In France this method was found very efficient. Culture tubes of the fungus are offered for sale. A number of the larvae are collected and the diluted contents of the tube are sprinkled over them. The

larvae are then buried for several hours in damp soil. This insures the inoculation of the larvae by the fungus. The larvae are then buried carefully throughout the infested area. The infected larvae transmit the fungus to other larvae. Methods of this kind have not proven of much value in this country as yet.

4. Carbon bisulphid. This has been used quite extensively and in much the same way as at Fort Valley. Two modifications of the method seem very feasible and valuable. The main disadvantage of carbon bisulphid as it is used for May-beetle larvae is that it disseminates too rapidly, especially in dry soil. A French manufacturer makes 5-gram capsules of CS_2 which have a covering of gelatine. The gelatine gradually dissolves by the action of moisture in the soil, and the CS_2 is given off gradually. These capsules have been used with success in this country.

A second solvent proposed is vaseline. Combined with vaseline, CS_2 is much more effective than without it. The vaseline prolongs the vaporization of the bisulphid for many days and greatly enhances its power of penetrating the soil.

The Use of Carbon Bisulphid at the Fort Valley Experiment Station

A map of the treated beds, together with the date and character of treatment is in the files of the Experiment Station.

Before the beds were treated, care was taken to remove all seedlings and transplants which had been killed from any cause whatsoever, so that any stock severely injured or killed after the treatment could be recorded.

Only one transplant bed was treated and counts were con-

fined to this bed and the two transplant beds of yellow pine near it, one of which is directly to the east of the treated bed, the other joins the treated bed on the north. The following is a summary of the dead transplants found on these three transplant beds. Only transplants whose death are directly attributable to May-beetle work are included.

	Number of Dead Transplants (May-beetle Work)		
	Treated bed	Untreated Bed (east)	Untreated Bed (North)
Date:			
July 22, 1913:	22	50	96
Aug. 8, 1913:	20	63	44

After the count on July 22, the dead seedlings were removed from the beds. This was also done after the count on August 22. Nothing conclusive is brought out by the following result of counts made on the transplant bed, when the various rows were kept separately. Rows were numbered from south to north.

Rows	No. of rows	No. of Seedlings Killed by May-Beetle. July 22, 1913	August 8, 1913	Treatment
1-7, inc.	7	1	2	55 c c in 25 openings, June 26, 1913.
8-15 "	8	2	2	No treatment
15-20 "	5	0	0	60 cc in 18 openings, June 26, 1913.
21-28 "	8	5	12	No treatment
29-33 "	5	3	0	60 cc in 10 openings, June 26, 1913.
34-41 "	8	4	1	No treatment
42-46 "	5	5*	0	40 cc in 18 openings, June 26, 1913.
47-54 "	8	0	1	No treatment
55-59 "	5	2	0	40 cc in 10 openings, June 26, 1913, and again on July 19, 1913

* All 5 in one row.

Only transplants which were killed by May-beetles were recorded. As far as I was able to see there was no death of seedlings due to excess of carbon bisulphid. The rainy season had not started and the soil was in a fairly dry condition. On July 1, 1913, the transplant bed was thoroughly watered.

The openings were made by the use of the dibble to the depth of 4-5 inches, and various sized doses poured in by the use of a small graduated vial, and then the opening immediately covered. Especial care was taken to firm the soil when replaced to prevent too rapid dissemination of the carbon bisulphid. No trouble or objection was found with this method except that when the soil was very dry difficulty was encountered in making an opening of sufficient depth. It was found advantageous to stick labels into the ground whenever an injection was to be made, and to remove the label just before the opening for the injection was made. Two men can distribute the labels on the area, make the openings and the injections, at the rate of 125 doses per hour, provided that the soil is in the proper condition for easy "dibbling".

The results of this preliminary experiment are not conclusive. The following are the main points to be determined:

1. The efficacy of CS_2 in killing May-beetle larvae.

2. The practicability of the method from the standpoint of cost of materials and time.

3. The relative efficacy of various sized doses on a unit of surface.

4. The relative efficacy of a given dose on a unit of surface when distributed in a small number of openings and a large number of openings.

5. The effect of the character and condition of the soil on the efficency of carbon bisulphid.

6. Doses per unit of surface which are injurious or fatal to the nursery stock.

Carbon bisulphid can be secured in 50 lb. quantities at 10-12 cents per lb., or from 22-26 cents per 1,000 grams.

Specimens of the adults and larvae collected in the Fort Valley Nursery were sent to John J. Davis, Experiment Station Building, La Fayette, Indiana. He is connected with the Bureau of Entomology and conceded to be the best authority on Lachnosterna in this country. Mr. Davis considers the specimens to be a spqcies of May-beetle hitherto undescribed, but will not commit himself until he has had an opportunity to inspect new material.